Electric Vehicles and the Customers

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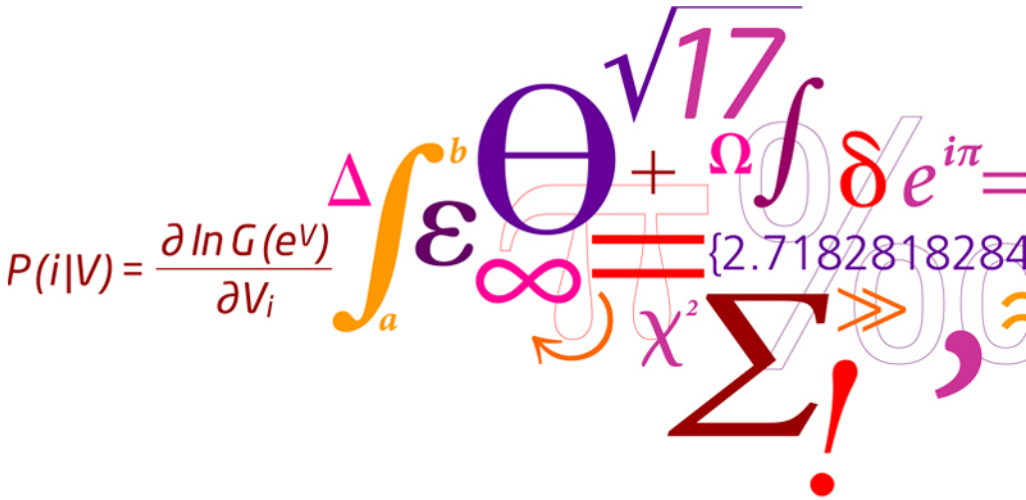

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Overview of the presentation

- Examples of attitudes of potential Customers
- Travel patterns derived from conventional cars
- Need for charging poles
- Examples of economic effects
- Optimisation of fast charging infrastructure
- Travel behaviour with different types and number of fast charging stations

Attitudes of the Customers and demand for EVs

Examples of attitudes of potential Customers

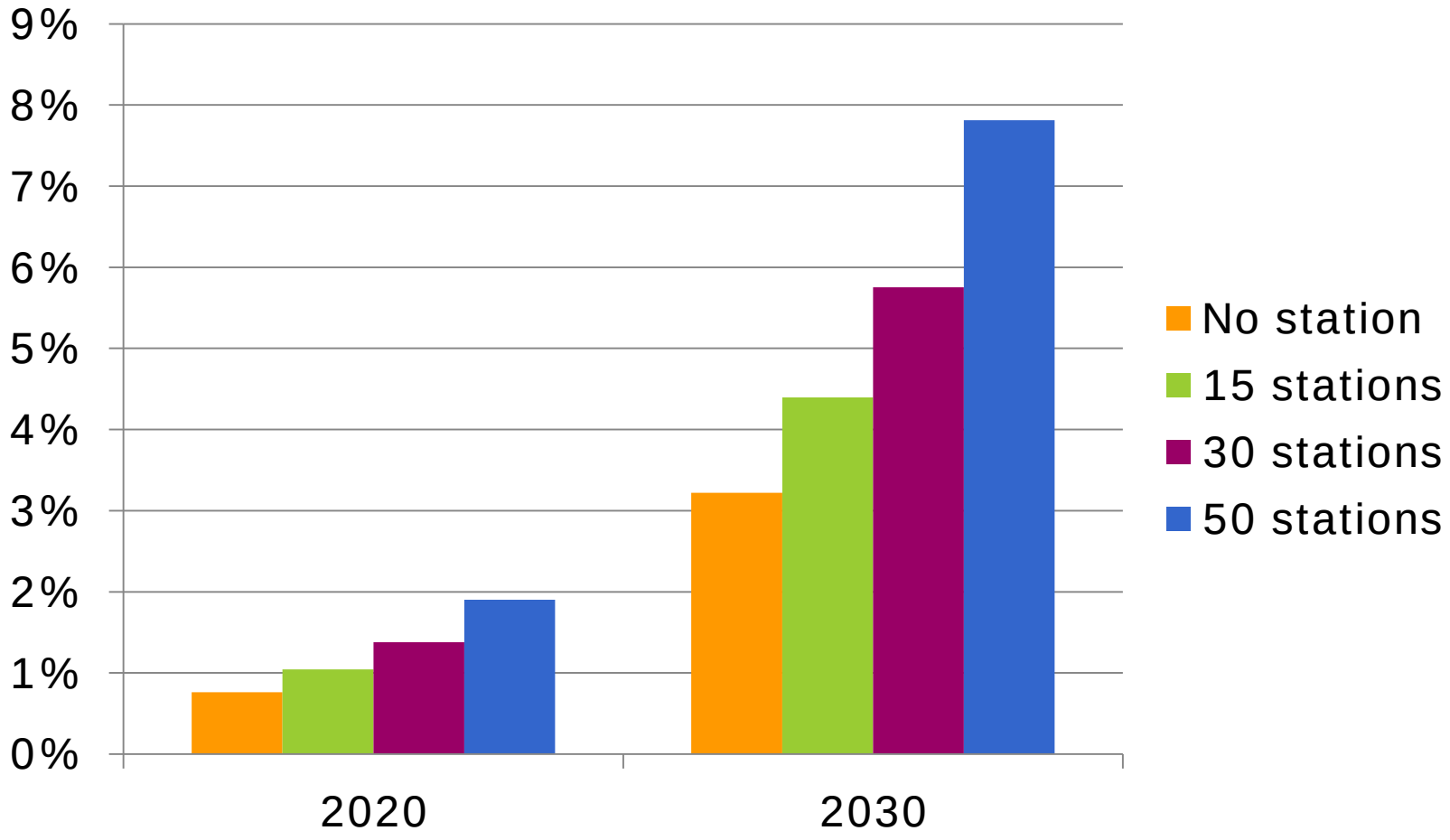
- The results are based on interviews with
  - Families participating in a trial with electric vehicles (Citroën C1)
  - users of public service cars of a municipality (Think City)
  - customers of an electric car sharing organisation (Think City)

- The interviewed finds the technology interesting
- But they don't find it full filling what they expect for a future car
  - The travel range is too short, especially for weekends and holidays
  - The top speed is too low
  - The charging time is much too long (typical 11 hours)
  - They loose the flexibility of a car, for instance when they suddenly need to go to a hospital or pick up a sick child when they are at work
  - The actual EV is not what they understand by a family car being able to bring the whole family on holiday, eventually with a caravan
  - The price is much too high even without purchase tax

An EV as car number two for daily city driving?

- This market will at least in Denmark be very small
- 69 % the Danish families only have 1 car. Even when 50 % are families with two or more driving licenses
- 50 % of the cars are owned by families with 2 or more cars
- However, families with 2 cars are driving as many kilometers per car in mean as families with 1 car. Only families who really need an extra car are offering to buy this extra car

A forecast of the EV stock as a share of the over all car stock for 5 minutes fast charge or battery switching

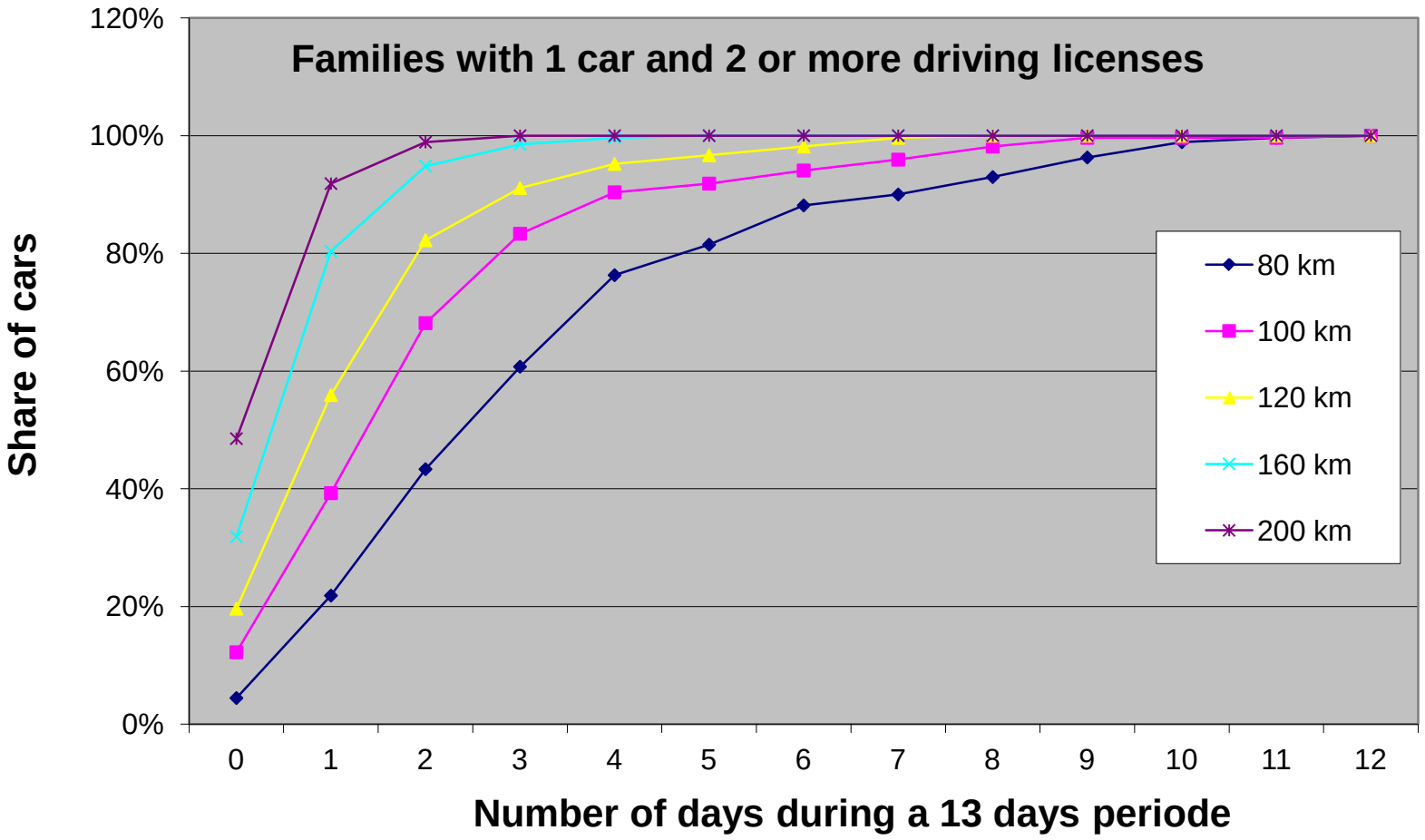


Driving patterns and need for charging based on data for conventional cars from the National Travel Survey

Share of cars with the actual driving pattern driving at the actual day which need to be charged during the day.

Number of cars in household Number of persons in household with driving license	**1 car** **1 with licence**	**1 car** **2 with licence**	**2 cars** **2 with licence**
Travel range:			
80 km	23 %	29 %	33 %
120 km	11 %	14 %	15 %
150 km	6 %	9 %	10 %
180 km	4 %	6 %	7 %

Need for charging away from home 0, 1, 2 etc. days during a period of 13 days.



Charging pole infrastructure

Activity where charging is needed

Travel range:	120 km	150 km
No need for charging during the day	90 %	94 %
Home charging during the day	1.4 %	0.9 %
Charging at work (eventually on top of at home)	2.4 %	1.4 %
Charging at shopping or City Centre (evt. on top of home and work)	0.7 %	0.4 %
Charging at visits (evt. on top of some of the above)	0.8 %	0.6 %
Charging at other activities (evt. on top of some of the above)	0.7 %	0.5 %
The rest to fast charging	3.8 %	2 %

6.1 % at charging poles

4 % at charging poles

The maximum need for charging as a share of the parking vehicles - if all cars were EVs

At normal days the travel range is assumed to be 120 km
The maximum need occur when the travel range is only 80 km

	Normal day	Maximum need
Work place	10 %	31 %
Education	10 %	30 %
Business travels and services	10 %	42 %
Town Centres	3 %	10 %
Shopping	2 %	11 %
Post offices, libraries, doctors etc.	1 %	13 %
Hospitals etc.	3 %	19 %
Sports activities	2 %	15 %
Other kind of club membership	3 %	15 %
Escorting to activities	1 %	5 %
Visiting friends and relatives	6 %	25 %
Home (not night charging)	3%	10%
Summer house	8 %	22 %

Number of needed parking lots with access to a charging pole for night charging in dense city areas if 100,000 families purchase an EV

	Total
Copenhagen and Frederiksberg municipalities	4,500
3 cities >100,000 inhabitants	1,500
Cities with 35-100,000 inhabitants	1,100
Cities with 20-35,000 inhabitants	600
Cities with 10-20,000 inhabitants	700
Cities with 5-10,000 inhabitants	600
Total	**9,000**

Number of needed parking lots with access to a charging poles for charging in dense city areas if 100,000 families purchase an EV

The practical charging range is assumed to be 120 km

	For work	For other non-home purposes	
	City centre	City centre	Total
Copenhagen and Frederiksberg municipalities	300	350	650
3 cities >100,000 inhabitants	150	250	400
Cities with 35-100,000 inhabitants	160	360	520
Cities with 20-35,000 inhabitants	80	170	250
Cities with 10-20,000 inhabitants	70	230	300
Cities with 5-10,000 inhabitants	90	200	300
Total	**850**	**1,550**	**2,400**

An example of how an investment in charging poles for 100,000 EVs could be financed

It is assumed that
- two cars can share one charging pole
- the residents finance 10,000 kr for access to a charging pole as residents in one family houses

	Investment Kr per pole			Needed investment	Interest rate	Yield over 10 years	Visits	Mean payment
	Number of poles	Night chargers	Guests	From guests		Per month	per month	per visit
City centres	4,000	20.000	30,000	120,000,000	7%	1,393,302	72,000	19.35
Other areas	1,000	0	50,000	50,000,000	7%	580,542	21,000	27.64
In all				170,000,000		1,973,844	93,000	21.22

An example of how an investment in 5.000 charging poles for 100,000 EVs could be financed

It is assumed that
- two cars can share one charging pole
- the residents finance 10,000 kr for access to a charging pole as residents in one family houses
- double use of charging poles day and night

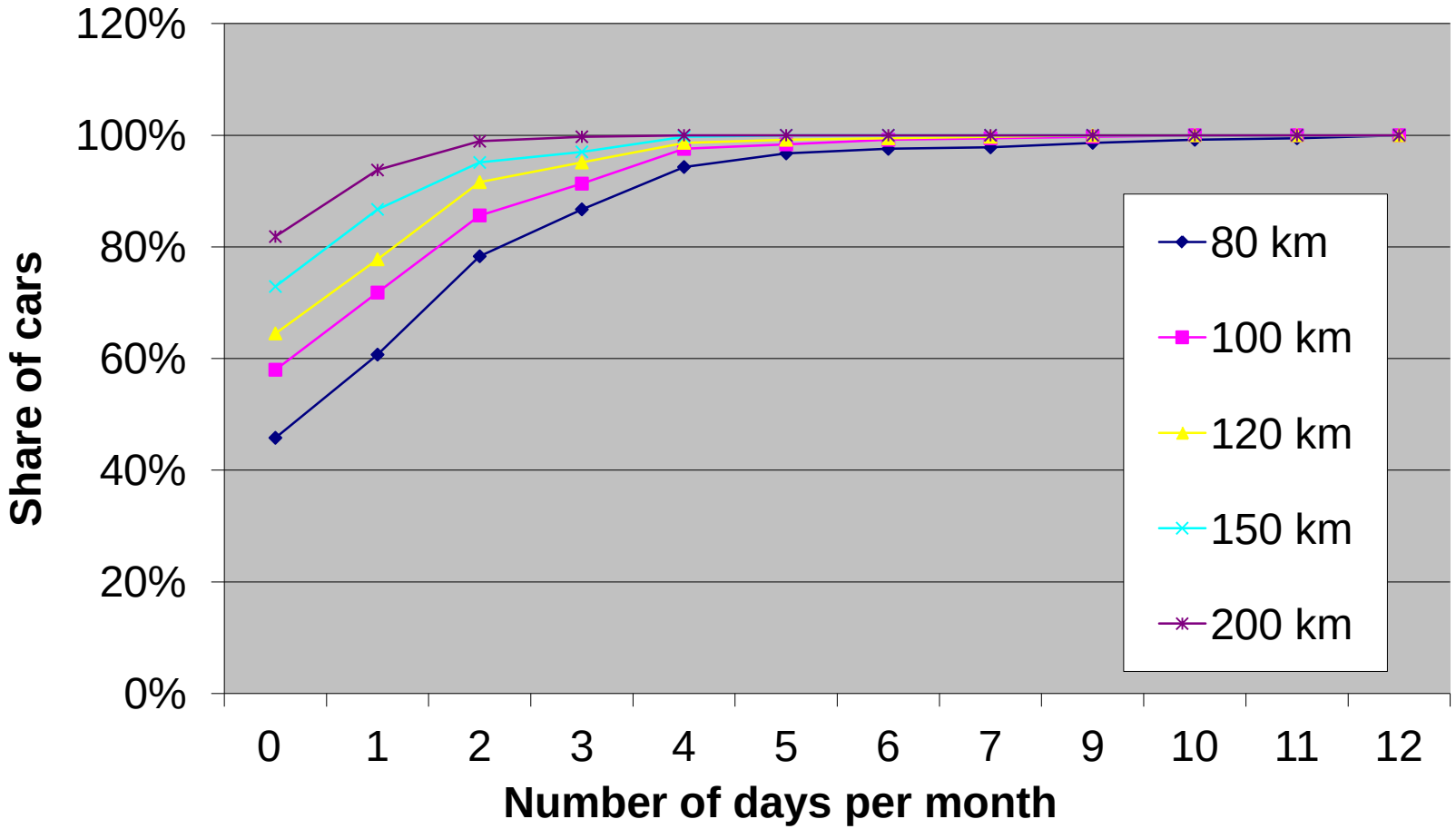
- 10 % of the charging visitors are subscribers with a monthly payment of 60 kr (8 EUR) for the right to charge
- 10,000 subscribers pay 600,000 kr per month

- 90 % of the charging visitors pay 20 kr per charging visit (2,70 eur) on top of the electricity price
- 90,000 EV owners making 70,000 visits and pay 1,400,000 kr

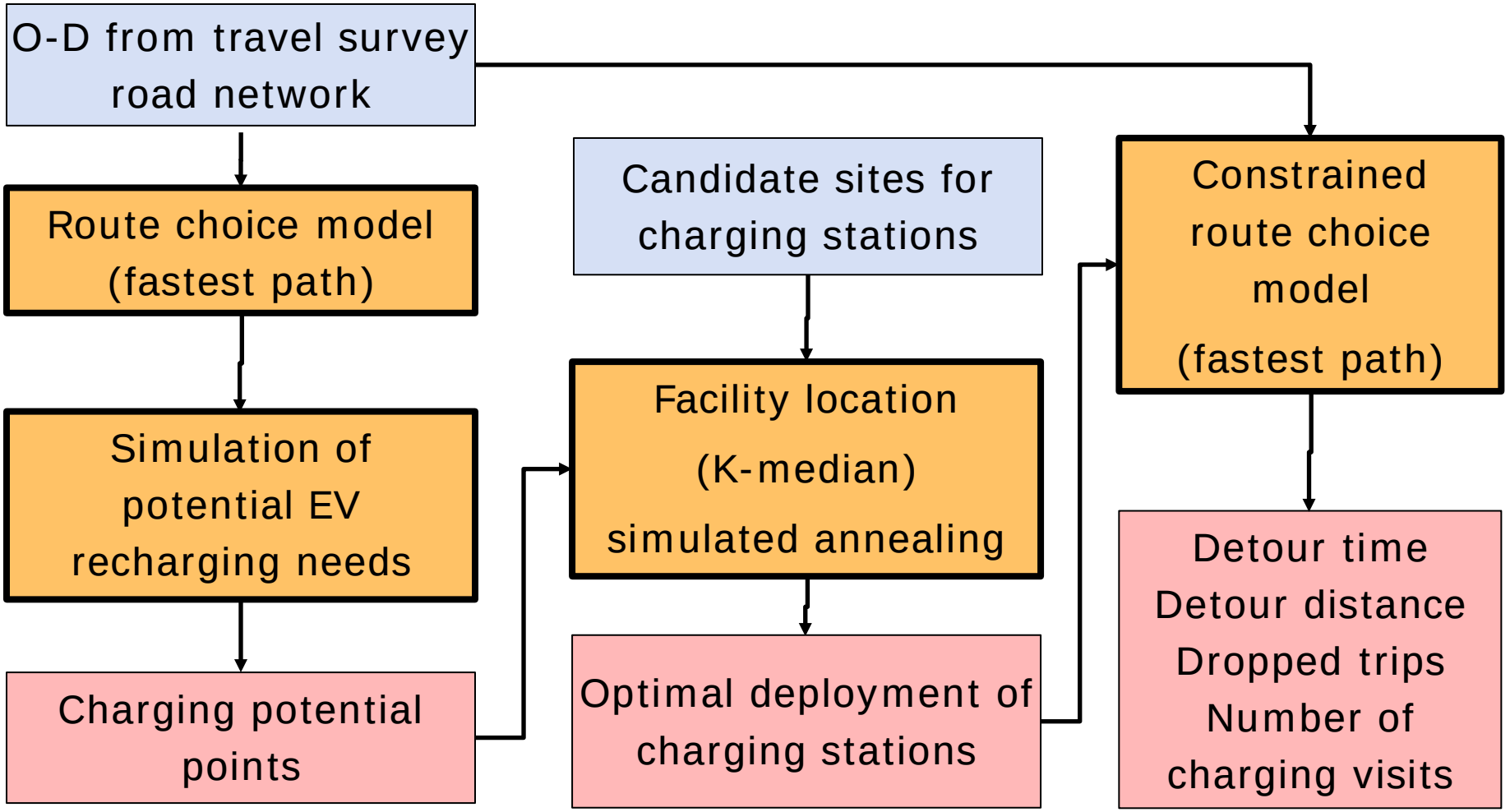
- Over all income per month 2,000,000 kr
- Needed income per month 1,975,000 kr

Fast charging stations

Share of cars that need to **fast charge during the day in** 1, 2 etc number of days over a month.

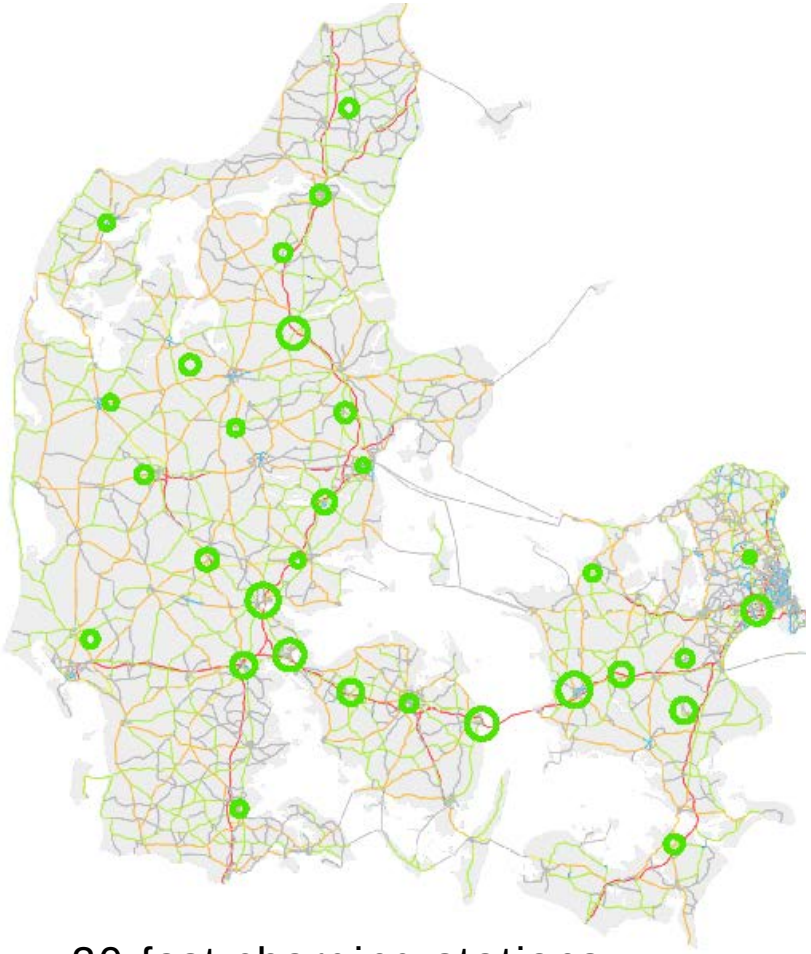


Model for optimising fast charging infra-structure. Based of travel patterns from NTS



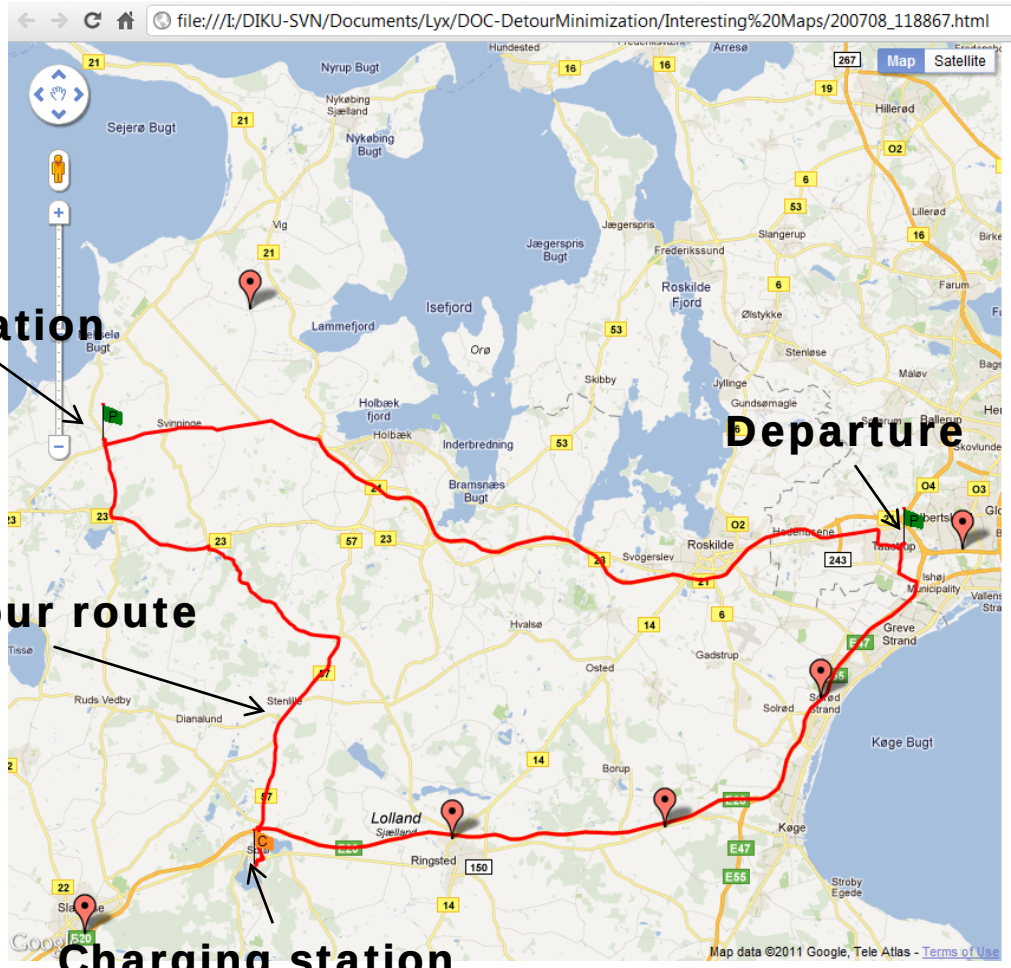
Localising of 15 and 30 quick charging stations with size of stations

15 fast charging stations



30 fast charging stations

Example of a detour in the fast charge model



Routes:

	Straight lines	Google Map routes
Recharge route♦	☐	☑
Original route♦	☐	☐

Original path

Visit	Action	rr	rt	Dist	Time	ra
S1	Departure			0.0	810.0	0.0
S2	Arrival			66.5	858.9	0.0
S2	Departure			66.5	1050.0	0.0
S3	Arrival			132.9	1098.6	0.0

Recharge path

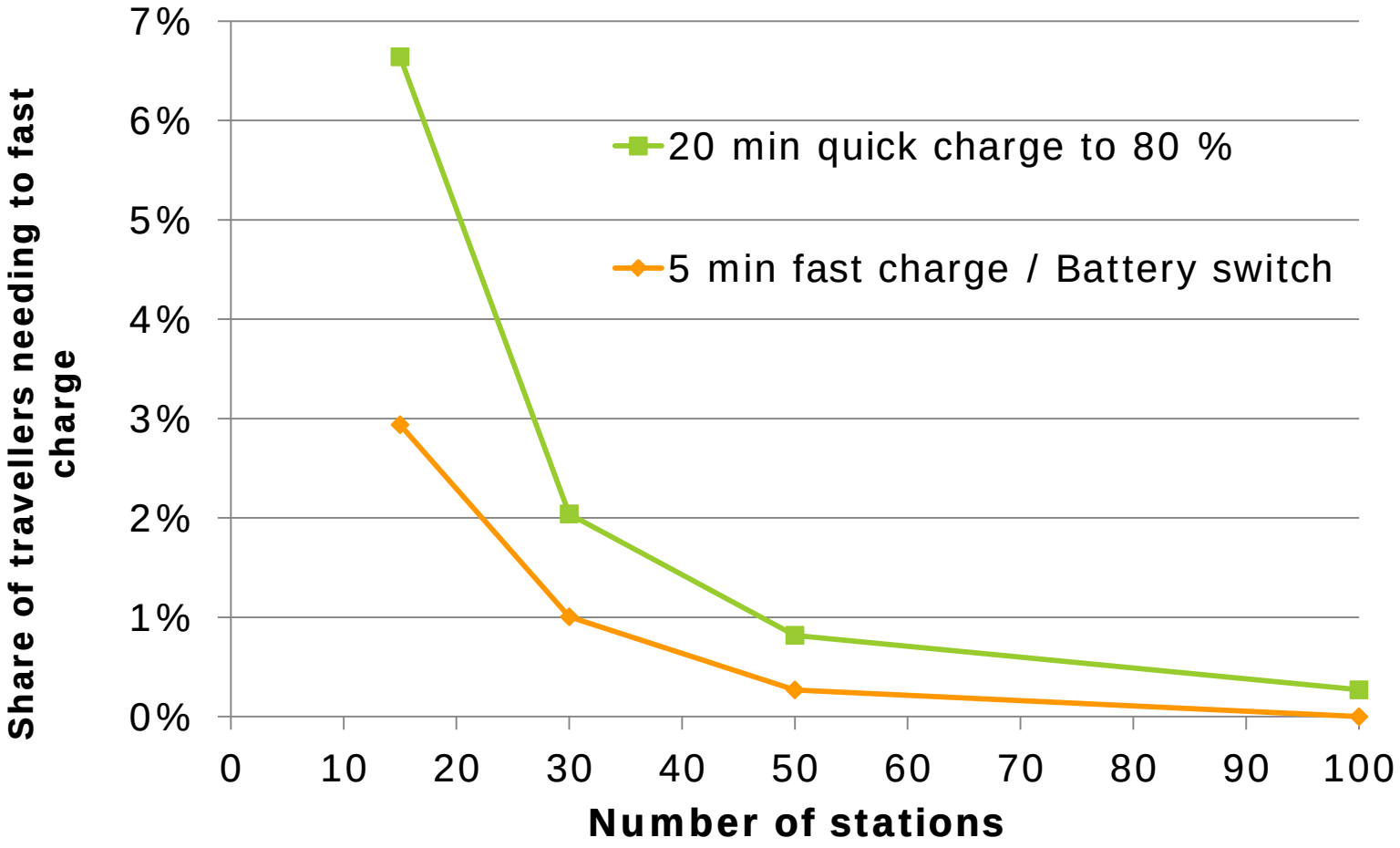
Visit	Action	rr	rt	Dist	Time	ra
S1	Departure			0.0	810.0	120.0
G546	Recharging		15.0	63.7	854.6	56.3
G546	Departure			63.7	869.6	108.0
S2	Arrival			103.2	903.6	68.4
S2	Recharging	0.0	146	103.2	903.6	68.4
S2	Departure			103.2	1050.0	68.4
S3	Arrival			169.6	1098.6	2.1

- rr = recharge rate(km/min)
- rt = recharge time(min)
- dist = distance(km)
- time = time(min)
- ra = range(km)

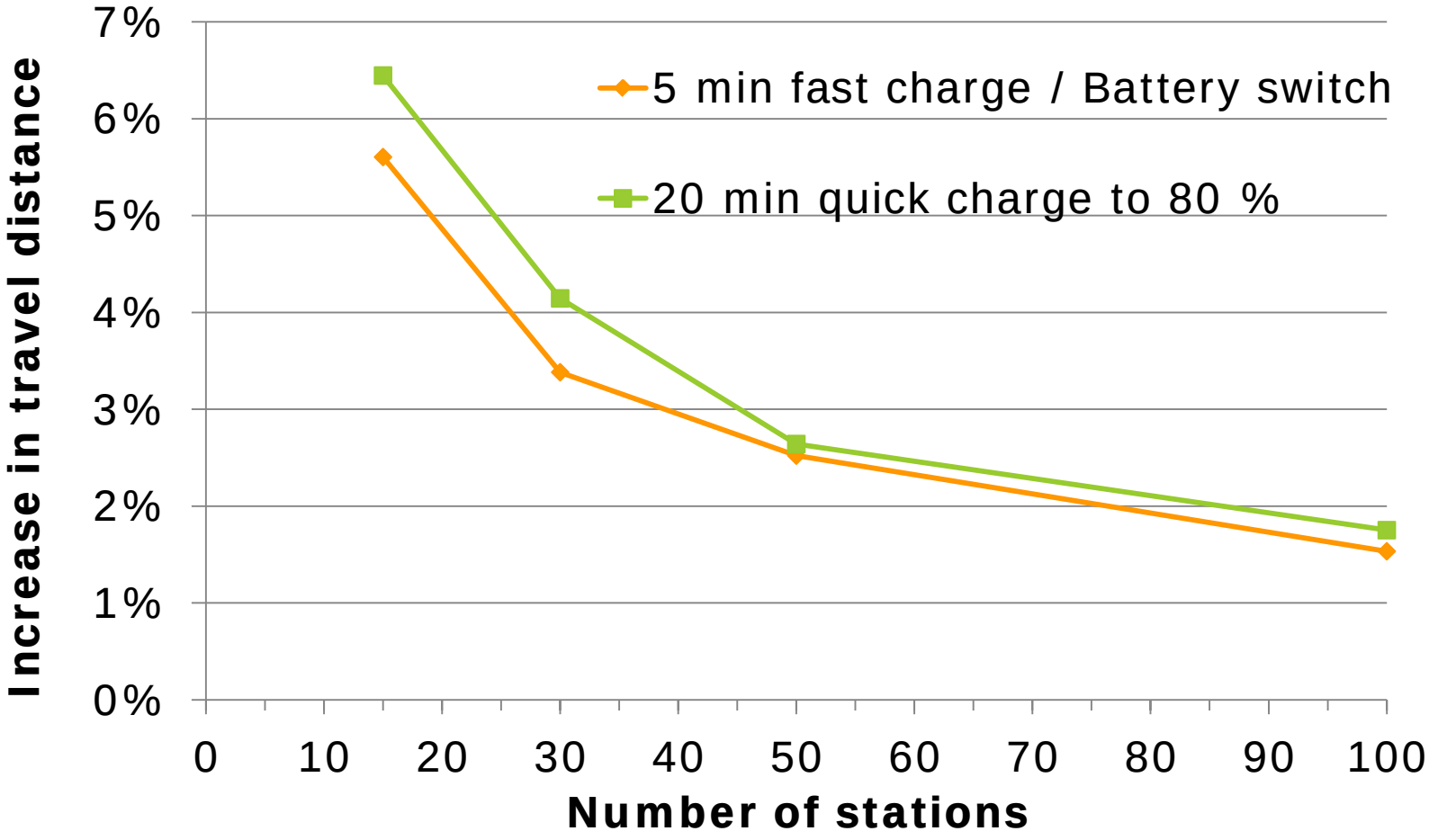
Premise for the conclusions

- The capacity of the battery on long distance travels is only 120 km
- If the driver wants to have a buffer of 20 km before running out of electricity 3.3 % of the EVs need to fast charge at the actual day
- If the driver reduces the speed and change route when the charge level is low it is possible to extent the driving distance. We handle this as if the driver has no buffer. In this case only 2.4 % need to fast charge at the actual day

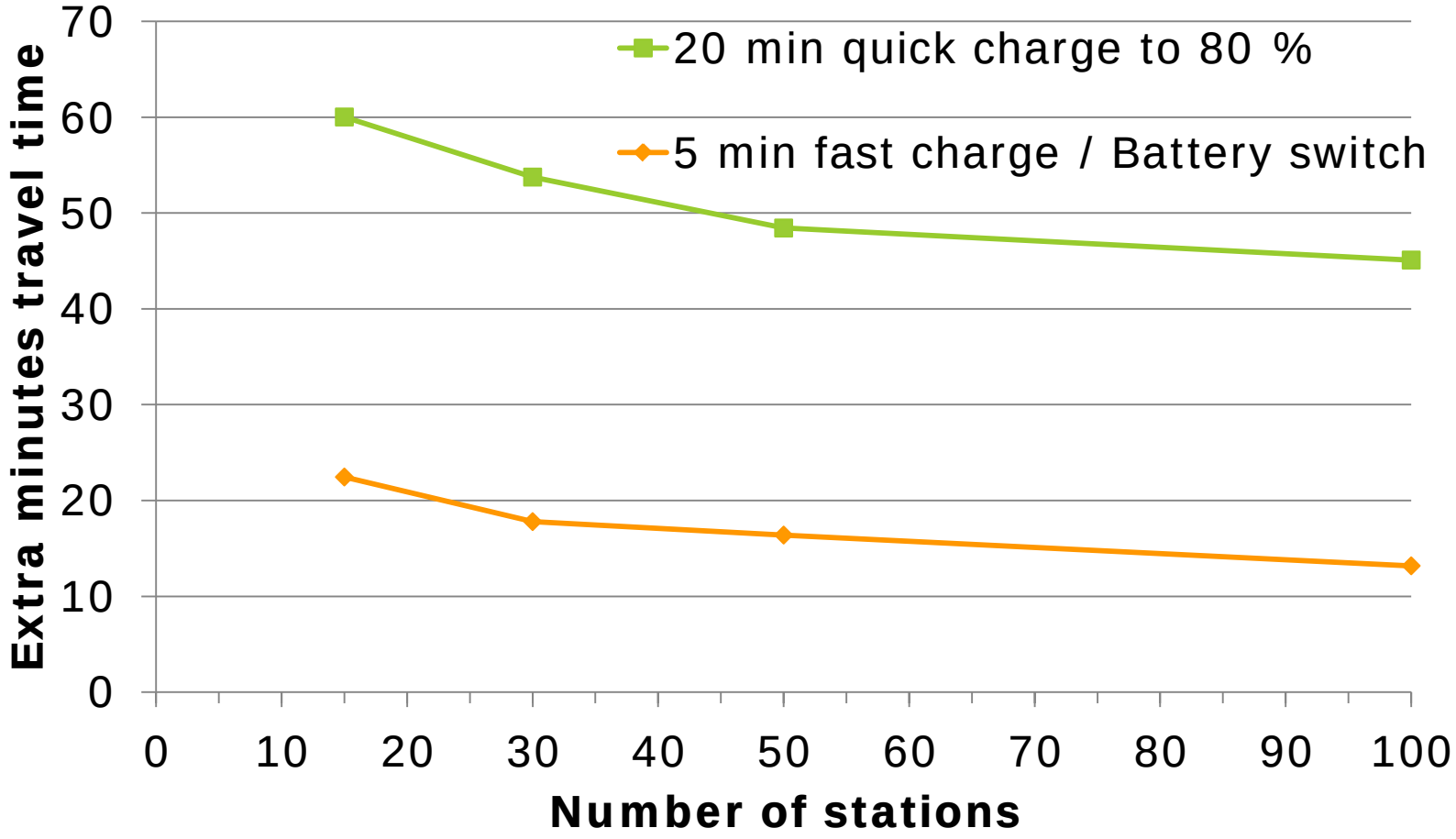
Share of cars needing to fast charge which cannot get to a fast charging facility



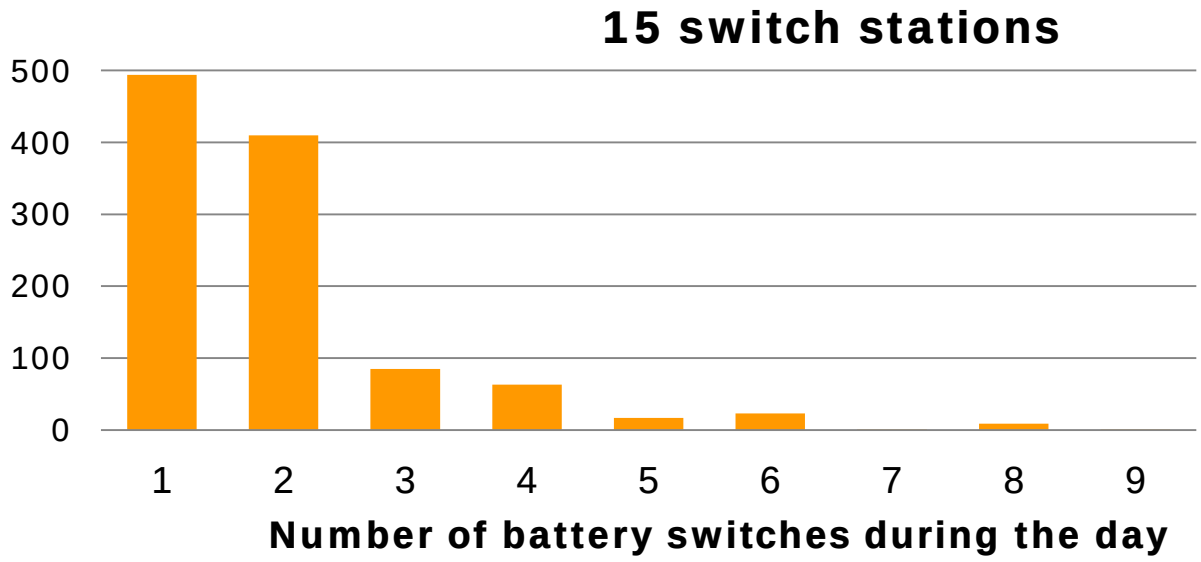
The increase in travel distance thanks to detours

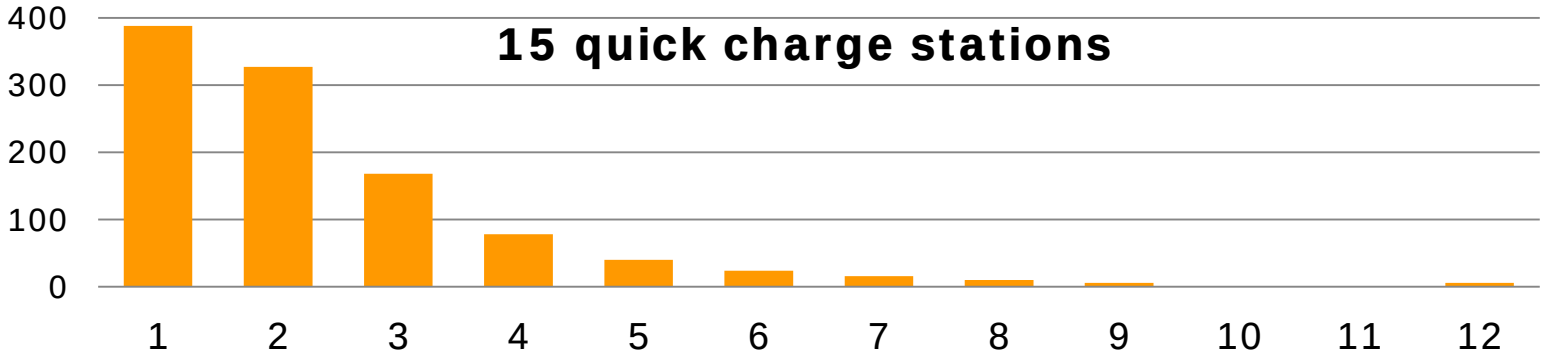


Extra travel time



How many times do the travellers need to fast charge during a day?





Acknowledgement I

The work is based on several projects

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